



Range extension and conservation of *Psophia interjecta* Griscom & Greenway, 1937 (Aves: Psophidae) in the Tocantins–Araguaia interfluve, state of Tocantins, Brazil

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Abstract

The genus *Psophia* includes terrestrial birds endemic to the Amazon. The number of species in this genus is still controversial, with alternative taxonomic treatments currently available. We present new and historical records of *P. interjecta* for the state of Tocantins, which extend this species' range to the Tocantins–Araguaia interfluve, in south-easternmost Amazonia. *Psophia interjecta* is considered Vulnerable in Brazil, but we discuss that the species is likely more Critically Endangered in Tocantins due to drastic deforestation and hunting.

Key words

Amazonia–Cerrado Ecotone; Araguaia River; Tocantins River; Trumpeters.

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Introduction

Trumpeters (Psophiidae) are predominantly terrestrial forest birds endemic to the Amazonian region. They feed on fruits, insects, and small vertebrates (Sick 1997, Sherman and Bonan 2013). The species-level taxonomy of *Psophia* is controversial. One taxonomic treatment recognizes 6 species: *Psophia crepitans* Linnaeus, 1758, *P. leucoptera* Spix, 1825, *P. ochroptera*, *P. viridis* Spix, 1825, *P. dextralis* Conover, 1934 and *P. obscura* Pelzeln, 1857

(Oppenheimer and Silveira 2009, Sherman and Bonan 2013). These species are supported by phylogeographic data (Ribas et al. 2012). However, phylogeographic data also provide evidence that *P. napensis* Sclater & Salvin, 1873 and *P. interjecta* Griscom & Greenway, 1937 are valid species, and thus, another treatment recognizes 8 species (Piacentini et al. 2015); it is adopted here.

Each *Psophia* species is restricted to a major Amazonian interfluve (Ribas et al. 2012). In the southeastern portion of the Amazon basin, *Psophia* species occur at

each interfluve as follows: *P. viridis* (Madeira-Tapajós), *P. dextralis* (Tapajós-Xingu), *P. interjecta* (Xingu-Tocantins), and *P. obscura* (east of the Tocantins) (Ribas et al. 2012). In the state of Tocantins, there is no record of *Psophia* to date, despite of the occurrence of ombrophilous dense forest also in the Tocantins–Araguaia interfluve (Dornas 2009), which is similar to the vegetation from the east-central Amazon. Both *P. dextralis* and *P. interjecta* are Vulnerable in Brazil, and *P. obscura* is Critically Endangered (MMA 2014).

Here, we describe the presence of *Psophia* in the state of Tocantins, including both recent and historical records from the past 35 years. We also compare mitochondrial DNA sequences (CytB and ND2) of a specimen collected in Tocantins with DNA sequences from Ribas et al. (2012); this comparative analysis, even, supports the occurrence of *P. interjecta* in this state. Finally, the conservation status of *Psophia* is discussed based on the new and historical records presented here.

Methods

From March 2012 to December 2015, we searched for *Psophia* during ornithological expeditions in 3 areas within the Tocantins–Araguaia interfluve in the Amazonian section of Tocantins state. The areas were: F1, a flooded tropical rain forest, Mata da Ozara, in São Sebastião do Tocantins ($05^{\circ}12' S$, $048^{\circ}22' W$); F2, an ombrophilous open forest, Mata da Sapucaia in Wanderlândia ($06^{\circ}43' S$, $048^{\circ}08' W$); and F3, an ombrophilous dense forest, Mata of Garimpinho in Araguaína ($07^{\circ}22' S$, $049^{\circ}11' W$) (Fig. 1). Fieldwork was conducted from 05:00 h to 13:00 h, and 16:00 h to 19:00 h. F1 and F3 areas were explored in a single 25-day expedition, amounting to about 250 hours of sampling in each area. In area F2 three 20-day expeditions were carried out, amounting to about 550 hours of sampling. Pre-existing trails and roads were prospected at the selected forest fragments. Concomitantly with the search days, we installed 3 camera traps in each area to potentially record individuals of *Psophia*.

Historical records were obtained through interviews with 3 local residents, over 60 years old, who have lived at or near the study areas within the Araguaia–Tocantins interfluve since at least the 1980s. Records were taken into account only when (1) the interviewee adequately described morphological features (i.e., small head, short tail, longed neck, and erect body with humpback aspect) and behaviour (i.e., typical nocturnal vocalization) of *Psophia*, which prevent confusion with other coexisting species such as guan (*Penelope* sp.) and curassow (*Crax* sp. or *Mitu* sp.); and (2) when the interviewee confidently referred to a location within the Tocantins–Araguaia interfluve.

For the molecular analyses, we sequenced the same mitochondrial DNA markers (cytochrome *b*, 941 bp and NADH dehydrogenase 2, 1041 bp) used by Ribas et al. (2012; sequencing methods detailed therein) for 1 specimen obtained in this study (voucher MPEG 81500).

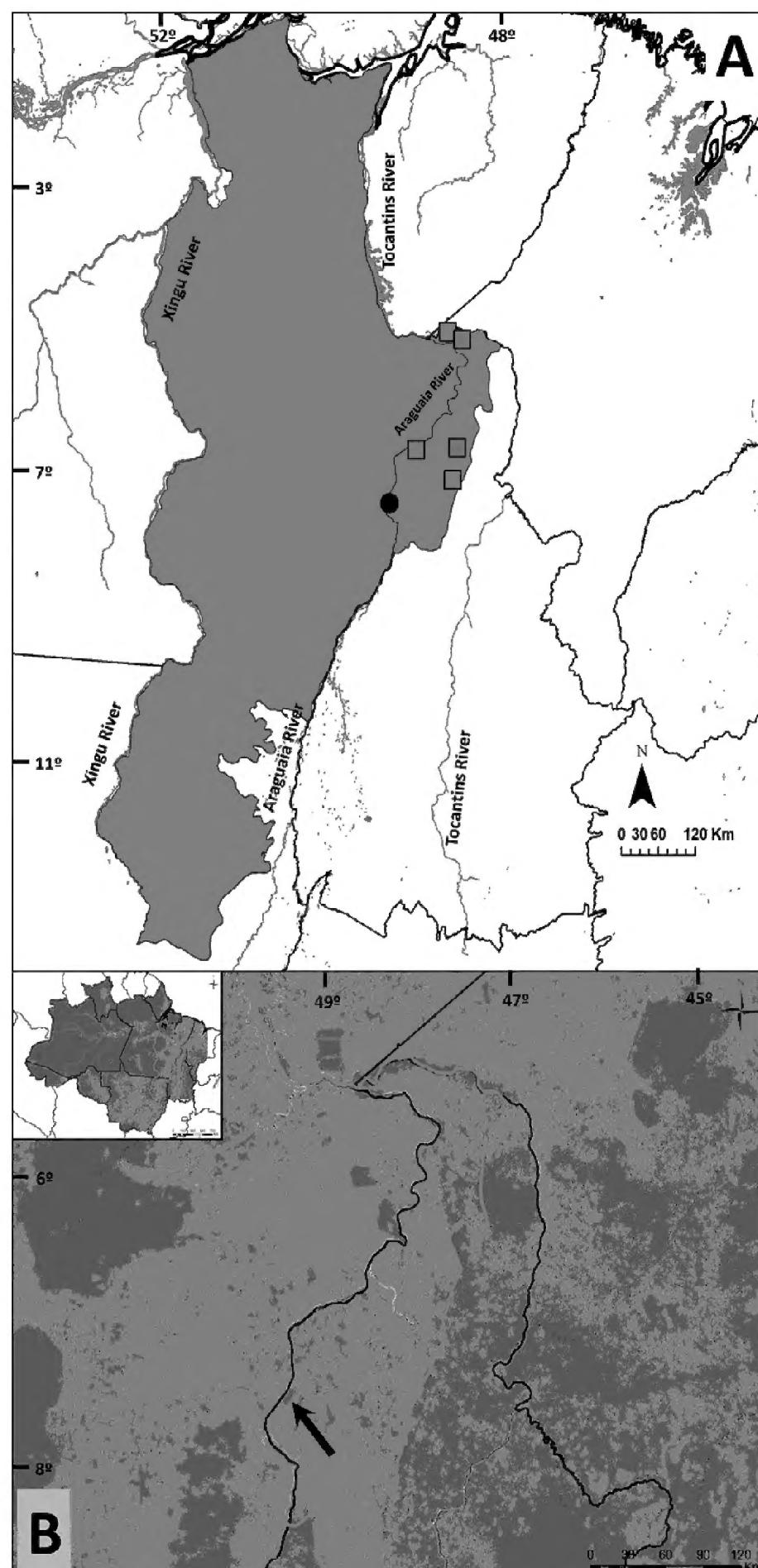


Figure 1. **A.** Current geographical range of *Psophia interjecta* (purple) and extension to Tocantins state (orange). Black dot is the area F3, where the specimen MPEG 81500 was collected. Squares represent historical records of *Psophia* reported by locals: yellow (1983), red (1985), blue (1998), green (2005, area F1), and brown (2006, area F2). **B.** *Psophia interjecta* range (yellow polygon) and the distribution of the remaining native vegetation (green) and disturbed areas (red) in the Brazilian Amazonia (INPE and EMBRAPA 2012). Arrow indicates the site F3.

Bayesian phylogenetic analyses were performed in Mr. Bayes software v.3.1.2 (Ronquist and Huelsenbeck 2003), following the same methods as Ribas et al. (2012). A haplotype network was generated using HaploViewer (Salzburger et al. 2011).

Results

We obtained 3 records of *Psophia*, all in the F3 area. The first record was made on 3 December 2013 when



Figure 2 *Psophia obscura*: MPEG 32002 from Ourém (left); MPEG 48495 from Santana do Araguaia (middle); MPEG 81500 from the Tocantins–Araguaia interfluve (area F3) (right).

an individual was seen at 6:00 h crossing a narrow road. On the same day at about 11:00 h, a flock of four individuals crossed the same road but 1 km away from the first record. As the sightings lasted only a few seconds, photographic documentation was not possible. At both times, identification to species was impossible because diagnostic characteristics were not observed of the potential species occurring in the area (i.e., *P. interjecta*, which reaches the western bank of the Tocantins and Araguaia rivers, Pará state, and *P. obscura*, which is found east of the Tocantins River).

A third record was made on 15 November 2015 when a dead individual was found in the F3 area. This specimen was collected and deposited in the Fernando C. Novaes Ornithological Collection of the Museu Paraense Emílio Goeldi, Belém-PA, Brazil (voucher number MPEG 81500). Plumage of our specimen was compared to other specimens from the same collection (MPEG 32002, *P. obscura* from Ourém, Pará, and MPEG 48496, *P. interjecta* from Santana do Araguaia, also Pará). We identified our specimens as *P. interjecta* (Fig. 2) by its diagnostic black-purplish neck with little iridescence, and olivaceous green back and cover feathers that distinguish *P. interjecta* and *P. dextralis* from *P. obscura* (Oppenheimer and Silveira 2009, Sherman and Bonan 2013). Furthermore, the Bayesian phylogeny and haplotype networks based on the same molecular mitochondrial markers ND2 and CytB grouped our specimen in the *P. interjecta* clade with high posterior probability (Fig. 3). In this same area (F3), an individual of *Psophia* was photographed on 28 March 2014 when at least 10 individuals were reported (Bichinski 2014). There was no

additional record of *Psophia* by the camera traps installed in any of the sampled areas, even in the F3 area where the species was recorded.

Interviews with locals yielded 5 additional potential records of *P. interjecta* in Tocantins, 3 of them between 1980 and 1999 and 2 in 2005 and 2006. We consider these to be “potential records” because we are not confident that these records are not *P. obscura*, which occurs to east of the right bank of the Tocantins River. Chronologically, records were obtained as follow (Fig. 1):

- 1983. According to the interviewee 1, an individual from a flock of 3 was hunted in the area F1 ($05^{\circ}17' S$, $048^{\circ}24' W$). He reported frequently seeing flocks of *Psophia* at that time when the landscape was predominantly covered by ombrophylous dense forest, called locally “Mata Fria”.
- 1985. Interviewee 2, a resident on the banks of the Araguaia River in the Pontal region, described *Psophia* flocks in the area of Pilões, approximately 30 km northwest of Araguaína ($07^{\circ}3' S$, $048^{\circ}13' W$) when the region was covered by continuous pristine forest. Nowadays this region is connected to forest patches of the Animal Science Campus of the Universidade Federal do Tocantins, where a recent and intensive ornithological inventory did not report any *Psophia* species despite historical records from local residents (Pascoal et al. 2016).
- 1998. Interviewee 2 also reported *Psophia* flocks in rainforests located on the right bank of the Araguaia River near Pontal ($06^{\circ}47' S$, $048^{\circ}46' W$). However, ornithological surveys in 2009/2010 and 2014/2015 (by TD and M.A. Crozariol, respectively) did not record *Psophia* in this area. Notably, this region has suffered dramatic deforestation over the past 15 years which could have been avoided by the implementation of the originally defined limits of the Barreira Branca State Park.
- 2005. Interviewee 1 also pointed out that local residents of the area F1 hunted probably the last pair of *Psophia* known in the legal reserve of the Nova União agrarian settlement ($05^{\circ}20' S$, $048^{\circ}21' W$). This legal reserve suffered intense selective logging and is now covered by secondary forest.
- 2006. Interviewee 3 reported *Psophia* flocks sighted more than once at area F2. However, surveys in this region in 2003 (Olmos et al. 2004) and between 2012 and 2015 (by TD, RTP and SMD) did not record trumpeters.

Discussion

Here we present the first records of *P. interjecta* for the Tocantins–Araguaia interfluve, which suggests that despite of over 300 years of ornithological inventories, the Amazonian portion of Tocantins is still poorly sampled for birds (Aleixo 2009, Dornas 2009). This lack of records is notable considering the number of previous ornithological expeditions in Tocantins (Buzetti 2001,

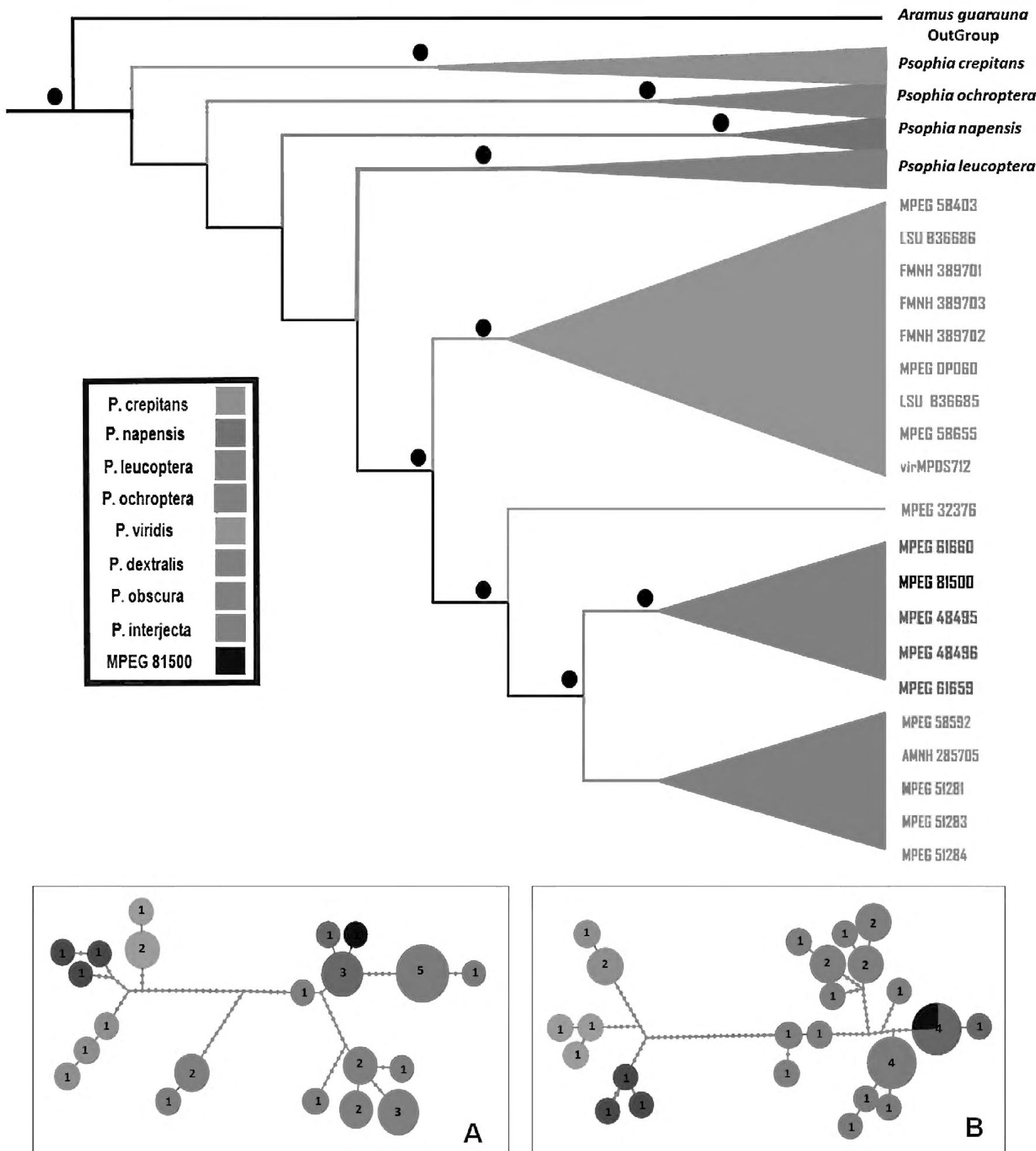


Figure 3. Phylogenetic tree from a Bayesian analysis of the CytB and ND2 sequences (concatenated genes, 1982 bp) placing the specimen MPEG 81500 within *Psophia interjecta* clade. Black circles correspond to posterior probability values with 95% of confidence. **A**, CytB haplotype network and **B**, ND2. Data extracted from Ribas et al. (2012: supplementary material).

Olmos et al. 2004, Pinheiro and Dornas 2009, Dornas and Pinheiro 2011, Pascoal et al. 2016) but also collecting expeditions by E. Snethlage on Bananal Island in 1926–1927 and J. Hidasi between 1960 and 1980 covering almost the entire state, including the Amazonian portion (Dornas and Pinheiro 2011).

Psophia interjecta were regularly recorded by camera traps on the left bank of the Araguaia River in southern Pará state between 2005 and 2007, but they were absent on the equally sampled right bank in the Cantão region (Negroes et al. 2007), which is located 250 km south of the F3 area. Additional records were also later obtained

from southern Pará state (Somenzari et al. 2011). Considering the high sampling effort, the lack of records in Tocantins suggests that *Psophia interjecta* is rare in the state and probably restricted to few patches of Amazonian Terra Firme forest in the north where currently deforestation is occurring at a high rate.

The records reported here from the Tocantins–Araguaia interfluvium extend the range of *Psophia interjecta* across the Araguaia River to the easternmost Amazon. However, records from area F3 suggests that *P. interjecta* currently occurs in a single 150 km² patch in Tocantins. We suggest that the historical range, on the other hand,

entirely overlapped with the ombrophylous forest cover of the Tocantins–Araguaia interfluve, coincided with the Amazonian forest in Tocantins, and covered approximately 20,000 km² (Fig. 1).

Considering the rate of deforestation, the conservation status of populations of *P. interjecta* in the Tocantins–Araguaia interfluve is likely critical. Amazonian forest in Tocantins was reduced to about 20% of its original extent (Moura 2014), and of 6 fragments larger than 250 km² in 1991, only 1 was larger than 250 km² in 2014 (exactly 368.68 km²; just 7.95% of the 20% of remaining vegetal cover; Moura 2014). The conservation status of *P. interjecta* is nationally Vulnerable (MMA 2014) and globally Endangered (IUCN 2016, as a population of *P. dextraalis*); this is mainly due to deforestation and overhunting. Indeed, records presented here from the region that has experienced the highest rate of deforestation in Amazonia (Fig. 1). In Tocantins, only 6 patches of Amazonian forest are larger than 150 km², and the remaining Amazonian forest is prioritized for logging according to the state forest plan (Plano Estadual de Florestas; SEMADES and STPC 2014). Moreover, our interviews with locals suggest a persistent hunting pressure on trumpeters.

Even though our records for the Tocantins–Araguaia interfluve increase this rare species' range, the conservation status of the Tocantins–Araguaia population is likely critical and the populations are in decline. We recommend some actions in Tocantins that would benefit populations of *Psophia interjecta*: (1) suspend all logging activities in ombrophylous forest; (2) enact a state law for zero deforestation, whether dense, open, mixed or transition ombrophylous forest (SEPLAN 2012); (3) establish full protection in public and private protected areas in Amazonian forest, including those that do not require expropriation of farms, such as Biological Reserves (Reserve Biologica, REBIO), Wildlife Refuges (Refúgio de Vida Silvestre, REVIS), or Private Natural Heritage Reserves (Reserva Particular do Patrimônio Natural, RPPN). We believe that these recommendations may advance the conservation of *P. interjecta* in Tocantins as well as all the associated biodiversity in the Tocantins–Araguaia Interfluve.

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Authors' Contributions

TD, DGM, SMD collected the data and carry out the field expeditions. RTP and AA capture support financial. TD did the sequencing process and molecular analyses. All authors wrote and discussed the text.

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